Hazus: Earthquake Global Risk Report

Region Name: EatonRoughs

Earthquake Scenario: eatonroughs2011cfmsh_m7p36_se

Print Date: May 21, 2024

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.

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General Description of the Region

Hazus-MH is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The earthquake loss estimates provided in this report was based on a region that includes 22 county(ies) from the following state(s):

California

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 45,979.45 square miles and contains 1,125 census tracts. There are over 1,723 thousand households in the region which has a total population of 4,677,149 peopleF. The distribution of population by Total Region and County is provided in Appendix B.

There are an estimated 1,651 thousand buildings in the region with a total building replacement value (excluding contents) of 918,480 (millions of dollars). Approximately 91.00 % of the buildings (and 67.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 93,151 and 99,173 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 1,651 thousand buildings in the region which have an aggregate total replacement value of 918,480 (millions of dollars) . Appendix B provides a general distribution of the building value by Total Region and County.

In terms of building construction types found in the region, wood frame construction makes up 87% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

Hazus breaks critical facilities into two (2) groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 101 hospitals in the region with a total bed capacity of 10,710 beds. There are 2,024 schools, 803 fire stations, 229 police stations and 37 emergency operation facilities. With respect to high potential loss facilities (HPL), there are no dams identified within the inventory. The inventory also includes no hazardous material sites, no military installations and no nuclear power plants.

Transportation and Utility Lifeline Inventory

Within Hazus, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 1 and 2.

The total value of the lifeline inventory is over 192,324.00 (millions of dollars). This inventory includes over 5,810.44 miles of highways, 6,606 bridges, 161,370.05 miles of pipes.

Table 1: Transportation System Lifeline Inventory

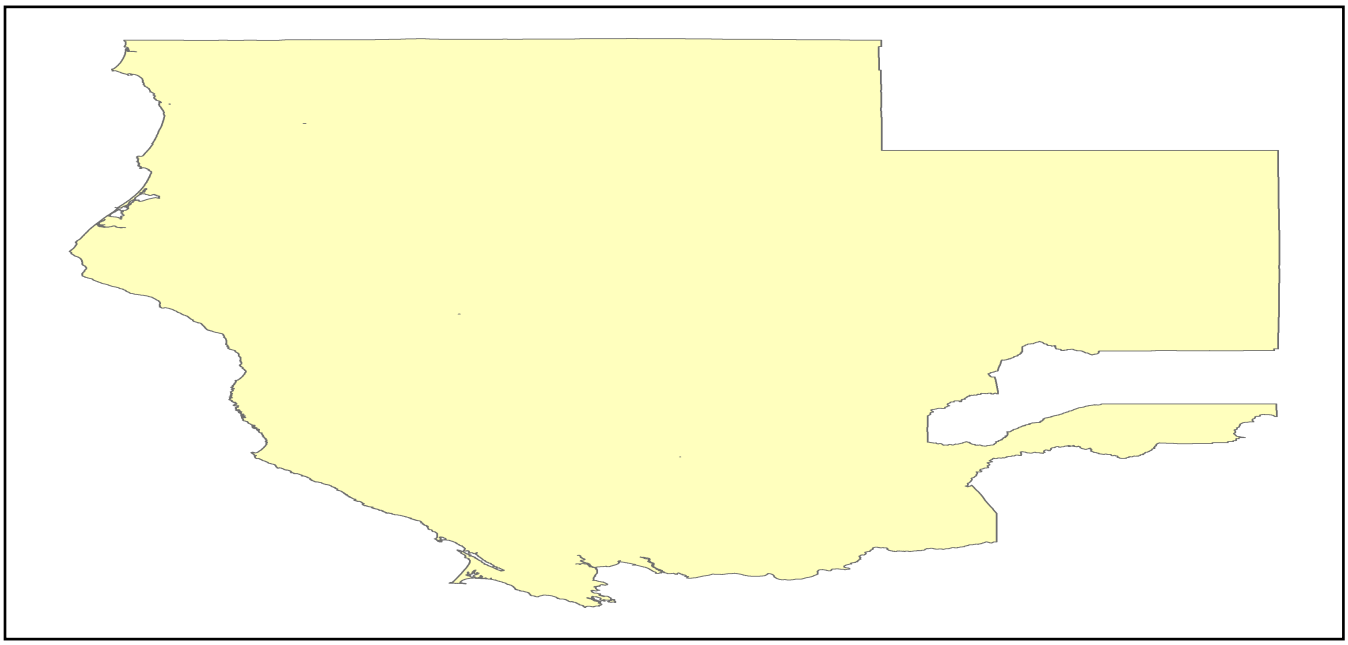
System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	6,606	22053.2312
	Segments	2,686	44836.3583
	Tunnels	11	153.1245
		Subtotal	**67042.7140**
Railways	Bridges	1,000	5690.0000
	Facilities	16	42.6080
	Segments	1,342	16338.3497
	Tunnels	0	0.0000
		Subtotal	**22070.9577**
Light Rail	Bridges	0	0.0000
	Facilities	55	314.0500
	Segments	3	1508.4477
	Tunnels	0	0.0000
		Subtotal	**1822.4977**
Bus	Facilities	21	48.1992
		Subtotal	**48.1992**
Ferry	Facilities	10	13.3100
		Subtotal	**13.3100**
Port	Facilities	136	518.4108
		Subtotal	**518.4108**
Airport	Facilities	79	898.3060
	Runways	103	736.9223
		Subtotal	**1635.2283**
		Total	**93,151.30**

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	3211.4956
	Facilities	7	275.0580
	Pipelines	0	0.0000
		Subtotal	**3486.5536**
Waste Water	Distribution Lines	NA	1926.8974
	Facilities	104	17882.9872
	Pipelines	0	0.0000
		Subtotal	**19809.8846**
Natural Gas	Distribution Lines	NA	1284.5983
	Facilities	3	123.7305
	Pipelines	634	9793.7702
		Subtotal	**11202.0990**
Oil Systems	Facilities	4	0.4720
	Pipelines	0	0.0000
		Subtotal	**0.4720**
Electrical Power	Facilities	179	64650.1747
		Subtotal	**64650.1747**
Communication	Facilities	204	24.0720
		Subtotal	**24.0720**
		Total	**99,173.30**

Earthquake Scenario

Hazus uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.



Scenario Name	eatonroughs2011cfmsh_m7p36_se
Type of Earthquake	User-defined
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	NA
Latitude of Epicenter	NA
Earthquake Magnitude	7.36
Depth (km)	NA
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	NA

Direct Earthquake Damage

Building Damage

Hazus estimates that about 1,895 buildings will be at least moderately damaged. This is over 0.00 % of the buildings in the region. There are an estimated 6 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

Damage Categories by General Occupancy Type

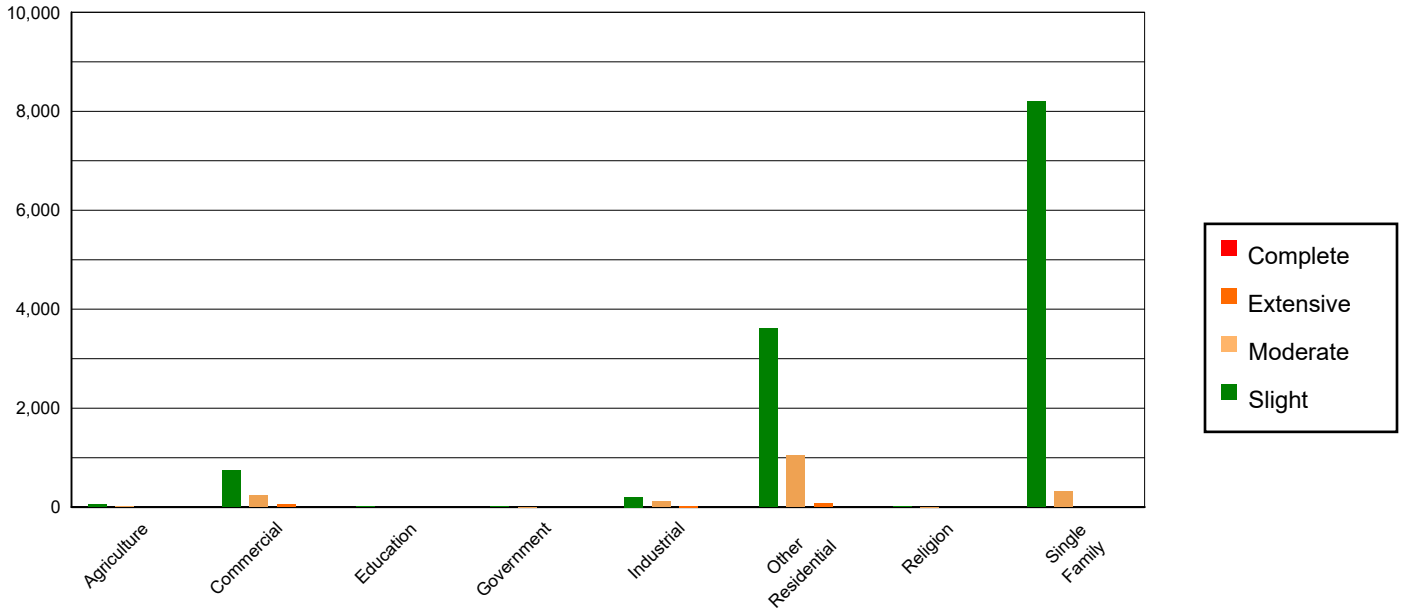


Table 3: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	10913.44	0.67	49.45	0.38	7.82	0.45	0.29	0.19	0.00	0.01
Commercial	101637.98	6.21	741.98	5.77	236.10	13.60	45.19	29.54	2.75	41.39
Education	3218.45	0.20	12.86	0.10	1.65	0.10	0.03	0.02	0.00	0.00
Government	3470.98	0.21	14.39	0.11	5.13	0.30	1.40	0.92	0.09	1.34
Industrial	26460.79	1.62	208.70	1.62	113.99	6.57	23.68	15.48	1.84	27.66
Other Residential	235961.08	14.41	3611.58	28.08	1045.39	60.23	81.02	52.95	1.93	29.03
Religion	5646.12	0.34	20.55	0.16	4.94	0.28	0.37	0.24	0.02	0.23
Single Family	1249779.16	76.34	8203.03	63.77	320.76	18.48	1.02	0.67	0.02	0.34
Total	**1,637,088**		**12,863**		**1,736**		**153**		**7**	

Table 4: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	1431966.97	87.47	10150.10	78.91	420.53	24.23	2.30	1.51	0.05	0.69
Steel	32202.89	1.97	319.94	2.49	169.19	9.75	32.47	21.22	3.14	47.37
Concrete	34975.22	2.14	342.23	2.66	151.95	8.75	48.45	31.66	2.40	36.13
Precast	21877.70	1.34	173.76	1.35	60.04	3.46	3.30	2.16	0.10	1.46
RM	46342.26	2.83	224.66	1.75	50.19	2.89	0.76	0.49	0.00	0.00
URM	4246.24	0.26	97.11	0.75	68.69	3.96	13.47	8.80	0.75	11.34
MH	65476.72	4.00	1554.77	12.09	815.20	46.96	52.26	34.16	0.20	3.00
Total	**1,637,088**		**12,863**		**1,736**		**153**		**7**	

*Note:
RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 10,710 hospital beds available for use. On the day of the earthquake, the model estimates that only 10,168 hospital beds (95.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 99.00% of the beds will be back in service. By 30 days, 100.00% will be operational.

Table 5: Expected Damage to Essential Facilities

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	101	0	0	95
Schools	2,024	1	0	1,971
EOCs	37	0	0	37
PoliceStations	229	0	0	229
FireStations	803	0	0	800

Transportation Lifeline Damage

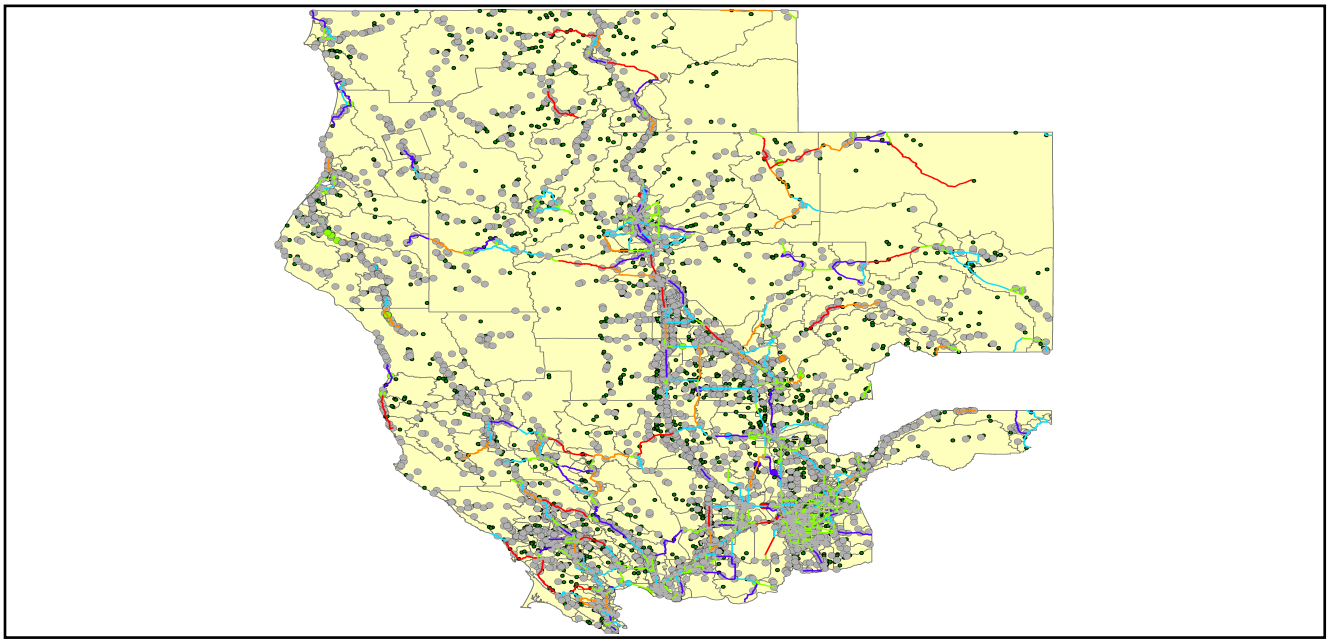


Table 6: Expected Damage to the Transportation Systems

System	Component		Number of Locations			
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	2,686	0	0	2,686	2,686
	Bridges	6,606	0	0	6,606	6,606
	Tunnels	11	0	0	11	11
Railways	Segments	1,342	0	0	1,342	1,342
	Bridges	1,000	0	0	1,000	1,000
	Tunnels	0	0	0	0	0
	Facilities	16	0	0	16	16
Light Rail	Segments	3	0	0	3	3
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	55	0	0	55	55
Bus	Facilities	21	0	0	21	21
Ferry	Facilities	10	0	0	10	10
Port	Facilities	136	0	0	136	136
Airport	Facilities	79	1	0	79	79
	Runways	103	0	0	103	103

Table 6 provides damage estimates for the transportation system.

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 7-9 provide information on the damage to the utility lifeline systems. Table 7 provides damage to the utility system facilities. Table 8 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, Hazus performs a simplified system performance analysis. Table 9 provides a summary of the system performance information.

Table 7 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	7	0	0	7	7
Waste Water	104	0	0	98	104
Natural Gas	3	0	0	3	3
Oil Systems	4	0	0	4	4
Electrical Power	179	4	0	177	179
Communication	204	10	0	204	204

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (miles)	Number of Leaks	Number of Breaks
Potable Water	99,777	1289	322
Waste Water	59,866	648	162
Natural Gas	1,728	0	0
Oil	0	0	0

Table 9: Expected Potable Water and Electric Power System Performance

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	1,723,902	343	77	0	0	0
Electric Power		2,670	1,540	529	29	4

Induced Earthquake Damage

Fire Following Earthquake

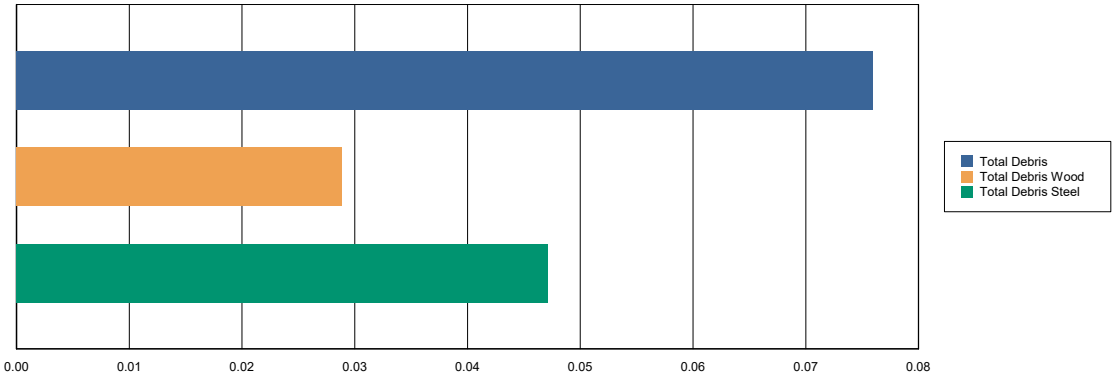
Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. Hazus uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 0 ignitions that will burn about 0.00 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 0 people and burn about 0 (millions of dollars) of building value.

Debris Generation

Hazus estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 76,000 tons of debris will be generated. Of the total amount, Brick/Wood comprises 38.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 3,040 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Earthquake Debris (millions of tons)



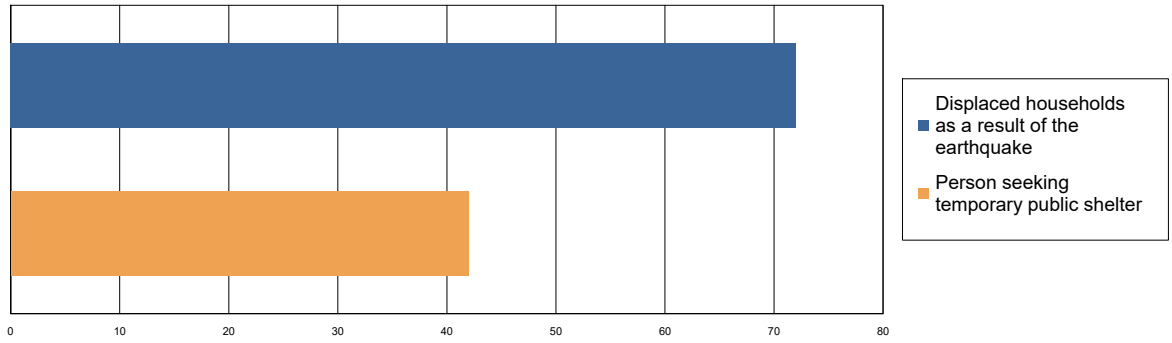
Brick/ Wood	Reinforced Concrete/Steel	Total Debris	Truck Load
0.03	0.05	0.08	3,040 (@25 tons/truck)

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 72 households to be displaced due to the earthquake. Of these, 42 people (out of a total population of 4,677,149) will seek temporary shelter in public shelters.

Displaced Households/ Persons Seeking Short Term Public Shelter



Displaced households as a result of the earthquake	Persons seeking temporary public shelter
72	42

Casualties

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 10 provides a summary of the casualties estimated for this earthquake

Table 10: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	0.20	0.02	0.00	0.00
	Commuting	0.00	0.00	0.01	0.00
	Educational	0.00	0.00	0.00	0.00
	Hotels	0.01	0.00	0.00	0.00
	Industrial	0.29	0.04	0.00	0.00
	Other-Residential	13.68	1.18	0.05	0.09
	Single Family	12.10	0.24	0.00	0.00
	Total	**26**	**1**	**0**	**0**
2 PM	Commercial	14.59	1.63	0.11	0.21
	Commuting	0.02	0.03	0.06	0.01
	Educational	7.04	0.56	0.01	0.01
	Hotels	0.00	0.00	0.00	0.00
	Industrial	2.09	0.26	0.02	0.03
	Other-Residential	4.71	0.42	0.02	0.03
	Single Family	4.02	0.09	0.00	0.00
	Total	**32**	**3**	**0**	**0**
5 PM	Commercial	9.98	1.08	0.07	0.13
	Commuting	0.41	0.58	0.94	0.18
	Educational	2.29	0.19	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	1.30	0.16	0.01	0.02
	Other-Residential	4.99	0.44	0.02	0.03
	Single Family	4.34	0.09	0.00	0.00
	Total	**23**	**3**	**1**	**0**

Economic Loss

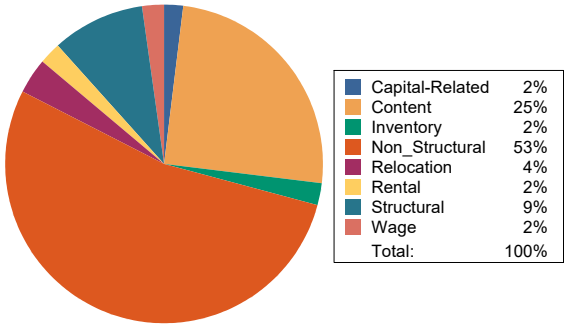
The total economic loss estimated for the earthquake is 1,167.53 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building-related losses were 667.74 (millions of dollars); 10 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 47 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

Earthquake Losses by Loss Type ($ millions)



Earthquake Losses by Occupancy Type ($ millions)

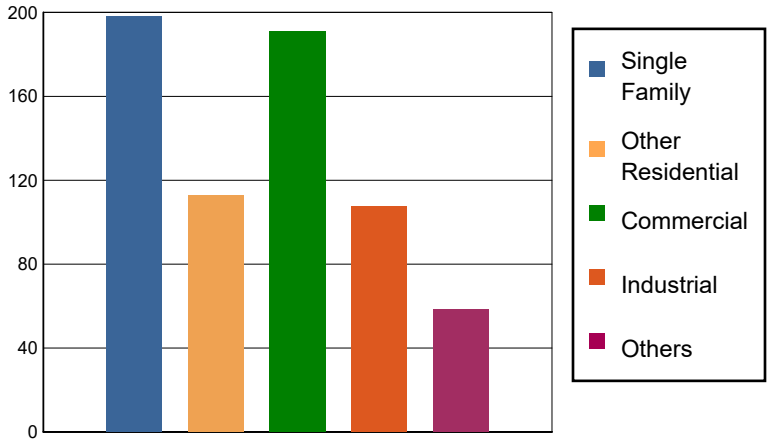


Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.0000	1.0117	10.2386	1.6848	1.6415	14.5766
	Capital-Related	0.0000	0.4301	10.5313	1.0482	0.4075	12.4171
	Rental	1.3023	3.8264	8.0520	0.7749	0.6833	14.6389
	Relocation	2.6916	3.7127	9.6987	3.7559	4.6719	24.5308
	Subtotal	**3.9939**	**8.9809**	**38.5206**	**7.2638**	**7.4042**	**66.1634**
Capital Stock Losses							
	Structural	17.6692	9.5217	18.9654	13.0649	4.0885	63.3097
	Non_Structural	125.3181	72.9692	79.1247	48.0051	31.3356	356.7527
	Content	51.3403	21.1358	46.9239	34.4539	13.9435	167.7974
	Inventory	0.0000	0.0000	7.4766	4.7542	1.4890	13.7198
	Subtotal	**194.3276**	**103.6267**	**152.4906**	**100.2781**	**50.8566**	**601.5796**
	Total	**198.32**	**112.61**	**191.01**	**107.54**	**58.26**	**667.74**

Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

Table 12: Transportation System Economic Losses
(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	44836.3583	0.0000	0.00
	Bridges	22053.2312	7.1704	0.03
	Tunnels	153.1245	0.0000	0.00
	Subtotal	**67042.7140**	**7.1704**	
Railways	Segments	16338.3497	0.0000	0.00
	Bridges	5690.0000	0.0716	0.00
	Tunnels	0.0000	0.0000	0.00
	Facilities	42.6080	0.1140	0.27
	Subtotal	**22070.9577**	**0.1856**	
Light Rail	Segments	1508.4477	0.0000	0.00
	Bridges	0.0000	0.0000	0.00
	Tunnels	0.0000	0.0000	0.00
	Facilities	314.0500	0.3360	0.11
	Subtotal	**1822.4977**	**0.3360**	
Bus	Facilities	48.1992	0.9386	1.95
	Subtotal	**48.1992**	**0.9386**	
Ferry	Facilities	13.3100	0.0071	0.05
	Subtotal	**13.3100**	**0.0071**	
Port	Facilities	518.4108	12.1139	2.34
	Subtotal	**518.4108**	**12.1139**	
Airport	Facilities	898.3060	14.7750	1.64
	Runways	736.9223	0.0000	0.00
	Subtotal	**1635.2283**	**14.7750**	
	Total	**93,151.32**	**35.53**	

Table 13: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.0000	0.0000	0.00
	Facilities	275.0580	0.1411	0.05
	Distribution Lines	3211.4956	5.8013	0.18
	Subtotal	**3486.5536**	**5.9424**	
Waste Water	Pipelines	0.0000	0.0000	0.00
	Facilities	17882.9872	128.2090	0.72
	Distribution Lines	1926.8974	2.9141	0.15
	Subtotal	**19809.8846**	**131.1231**	
Natural Gas	Pipelines	9793.7702	0.0000	0.00
	Facilities	123.7305	0.1524	0.12
	Distribution Lines	1284.5983	0.9984	0.08
	Subtotal	**11202.0990**	**1.1508**	
Oil Systems	Pipelines	0.0000	0.0000	0.00
	Facilities	0.4720	0.0001	0.02
	Subtotal	**0.4720**	**0.0001**	
Electrical Power	Facilities	64650.1747	325.2999	0.50
	Subtotal	**64650.1747**	**325.2999**	
Communication	Facilities	24.0720	0.7419	3.08
	Subtotal	**24.0720**	**0.7419**	
	Total	**99,173.26**	**464.26**	

Appendix A: County Listing for the Region

Butte,CA

Colusa,CA

Del Norte,CA

Glenn,CA

Humboldt,CA

Lake,CA

Lassen,CA

Marin,CA

Mendocino,CA

Napa,CA

Placer,CA

Plumas,CA

Sacramento,CA

Shasta,CA

Siskiyou,CA

Solano,CA

Sonoma,CA

Sutter,CA

Tehama,CA

Trinity,CA

Yolo,CA

Yuba,CA

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
California					
	Butte	211,632	25,875	16,639	42,514
	Colusa	21,839	2,244	2,024	4,268
	Del Norte	27,743	5,004	1,876	6,881
	Glenn	28,917	2,791	3,717	6,508
	Humboldt	136,463	19,361	8,683	28,044
	Lake	68,163	9,699	4,530	14,229
	Lassen	32,730	4,033	2,008	6,042
	Marin	262,321	47,738	15,030	62,769
	Mendocino	91,601	14,237	8,510	22,748
	Napa	138,019	20,517	13,045	33,563
	Placer	404,739	69,985	24,193	94,179
	Plumas	19,790	6,128	2,276	8,405
	Sacramento	1,585,055	179,811	83,911	263,723
	Shasta	182,155	21,572	15,715	37,288
	Siskiyou	44,076	6,856	4,758	11,615
	Solano	453,491	55,802	26,393	82,195
	Sonoma	488,863	68,827	35,781	104,609
	Sutter	99,633	10,618	6,448	17,066
	Tehama	65,829	7,705	5,113	12,818
	Trinity	16,112	2,209	1,485	3,694
	Yolo	216,403	24,130	18,343	42,473
	Yuba	81,575	8,161	4,677	12,839
Total Region		**4,677,149**	**613,303**	**305,155**	**918,470**